CANDIDATE'S NUMBER

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Tests
D-2
Chem. 30
Supp. 1967

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DEPARTMENT
EDUCATION ALBERTA

HIGH SCHOOL AND UNIVERSITY MATRICULATION

EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1967

SUPPLEMENTAL

CHEMISTRY 30

Time — 3 hours.

Total Possible Mark — 174.

Note—DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION. READ THE DIRECTIONS FOR EACH QUESTION CAREFULLY.

Do not write your name on this booklet.

Mathematical tables may be used.
Slide rules are permitted.

Page 2A contains the Periodic Table. This page, for convenience, should be torn along the perforation for ready reference when required.

Answers to questions 1 to 40 will be machine scored. Record your answers on the separate answer sheet provided.

Answers to questions 41 to 59, inclusive, are to be recorded in this booklet.

Rough work and diagrams may be done in pencil.
Finished work must be done in ink (blue or black, pen or ballpoint).

In solutions to problems enough work must be shown to indicate the method used.
Include units.

DO NOT FOLD THE BOOKLET.

Place your answer sheet **BEHIND** the test booklet and **INSERT BOTH IN THE SAME ENVELOPE** in such a way that the **UPPER LEFT HAND CORNER OF THE BOOKLET** (Candidate's Number) shows through the **SLASHED CORNER** of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

USE THE ATOMIC WEIGHTS SHOWN IN THE PERIODIC TABLE.

Gas Constant, R = 0.0821 liters-atmospheres per degree-mole.
1 faraday = 96,500 coulombs.

Booklet Score
Machine Score
Final Score

(For the use of Sub-examiners only)

LB
3054
C2
D419
1967a
chem.30

CURR HIST

In questions 1 to 40, inclusive, select the BEST answer of the four given answers and record it on the separate answer sheet, as shown in the example.

EXAMPLE	ANSWERS	ANSWER SHEET
The formula for sulfuric acid is	A. H_2SO_5 B. H_2SO_4 C. H_2SO_3 D. H_2SO_2	A ┅ B ▬ C ┅ D ┅

Each correct answer has a value of 2 marks for questions numbered 1 to 40 inclusive.

You are to use an ORDINARY HB PENCIL to mark your answers on the answer sheet. Make certain your answer marks are heavy and black. If you change your mind about an answer, be sure to erase your first mark completely. There should be only one answer marked for each question. Be sure there are no stray pencil marks on your answer sheet.

1. A sample of a compound contains 27.0 gm. of boron (B). If the compound is composed of 3 atoms of chlorine (Cl) for every one atom of boron the weight of chlorine present in the sample is

1. A. 572 gm.
B. 266 gm.
C. 106 gm.
D. 88.7 gm.

2. One atom element X weighs 5.15×10^{-23} gm. Element X is

2. A. Cl
B. S
C. P
D. Si

3. The element which has a higher first ionization potential than element of atomic number 56 is

3. A. Be
B. Cs
C. Ra
D. Fr

4. The fourth principal energy level of an atom may contain a maximum of

4. A. four orbitals
B. six p orbitals
C. fourteen f electrons
D. sixteen electrons

5. The atomic number of calcium is 20. Which of the following statements concerning calcium is NOT known from this information?

5. A. A neutral atom of calcium has 20 electrons
B. The nuclear charge of a calcium atom is plus 20
C. The calcium atom has two valence electrons
D. The neutral calcium atom has an atomic weight of 40 a.m.u.

6. The sodium ion, Na^+, has the same number of electrons as each of those listed EXCEPT

6. A. Al^{+++}
B. F^-
C. Ca^{++}
D. Mg^{++}

FOR ROUGH WORK

(No marks given for work in this space)

Tear this page out for ready reference when required.

PERIODIC TABLE

PERIOD	GROUP		TRANSITION ELEMENTS GROUP										GROUP					GROUP
	1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	0
1											1 H 1.0							2 He 4.0
2	3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
3	11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
4	19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc ---	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-71 See La Series	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At ---	86 Rn (222)
7	87 Fr ---	88 Ra 226.0	89-103 See Ac Series															

La Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm ---	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Ac Series	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np —	94 Pu —	95 Am —	96 Cm —	97 Bk —	98 Cf —	99 Es —	100 Fm —	101 Md —	102 No —	103 Lw —

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7. Which of the following compounds is molecular?

7. A. ICl
B. KCl
C. MgO
D. NaOH

8. The most CORRECT electronic formula for the compound calcium chloride, $CaCl_2$, is

8. A. $\left[\mathrm{Ca}^{++}\right]\ 2\ \left[\mathrm{Cl}^{-}\right]$
B. $\left[:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:\right]^{-}\ \mathrm{Ca}^{++}\ \left[:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:\right]^{-}$
C. $:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{C}}}:\ \mathrm{Ca}\ :\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:$
D. $\mathrm{Cl} - \mathrm{Ca} - \mathrm{Cl}$

9. The three steps for the formation of the ionic bond in potassium fluoride, KF, are

$$\mathrm{K}\cdot \longrightarrow \mathrm{K}^{+} + 1e^{-} \qquad (1)$$

$$:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{F}}}: + 1e^{-} \longrightarrow \left[:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{F}}}:\right]^{-} \qquad (2)$$

$$\mathrm{K}^{+} + \left[:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{F}}}:\right]^{-} \longrightarrow \mathrm{K}^{+}\left[:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{F}}}:\right]^{-} \qquad (3)$$

Which of the statements concerning these steps is TRUE?

9. A. Energy is released in step 1
B. The total energy of step 1 and step 2 must be greater than that of step 3
C. The total energy of step 2 and step 3 must be greater than that of step 1
D. Energy is required in step 2

10. Which of the following groups contain formulas of polar covalent molecules only?

10. A. HF, NH_3, CO_2
B. CH_4, H_2O, HBr
C. CaF_2, H_2S, SO_2
D. SO_3, CO, BrCl

11. $2CrO_2^{-} + 3HO_2^{-} \rightarrow 2CrO_4^{=} + H_2O + OH^{-}$

The oxidizing agent in the given balanced equation is

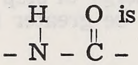
11. A. CrO_2^{-}
B. HO_2^{-}
C. $CrO_4^{=}$
D. OH^{-}

12. The magnitude of equilibrium vapor pressure depends on

12. A. pressure of the liquid and temperature of the liquid
B. atmospheric pressure and the temperature of the liquid
C. the nature of the liquid and atmospheric pressure
D. the nature of the liquid and the temperature of the liquid

FOR ROUGH WORK

(No marks given for work in this space)

13. The occurrence of different crystal forms of sodium chloride is called	**13.** A. polymorphism B. amorphism C. isomerism D. polymerism
14. The substance whose water solution is the poorest conductor of electricity is	**14.** A. CH_3COOH B. H_2SO_4 C. $C_3H_5(OH)_3$ D. HCl
15. If 50 milliliters of 0.20M solution of NaOH are required to neutralize 10 milliliters of H_2SO_4 solution, the molarity of the acid is	**15.** A. 5.0 M B. 1.0 M C. 0.5 M D. 0.1 M
16. The mass of a reactant that furnishes or acquires Avogadro's number of electrons is the	**16.** A. gram mole B. gram formula C. gram atom D. gram equivalent
17.  $-\overset{\overset{\large H}{\mid}}{N}-\overset{\overset{\large O}{\parallel}}{C}-$ is known as	**17.** A. an amine B. a ketone C. a zwitter ion D. a peptide link
18. The cleansing action of soap is thought to arise from the dissolving of grease in hydrocarbon clusters. These clusters are known as	**18.** A. cyclo-paraffins B. saccharides C. esters D. micelles
19. Which of the following is a polyfunctional alcohol?	**19.** A. glycerine B. stearin C. aspirin D. isoamyl acetate
20. 2 – methyl – 2 – propanol is another name for	**20.** A. primary butyl alcohol B. secondary butyl alcohol C. tertiary butyl alcohol D. n-butanol

FOR ROUGH WORK

(No marks given for work in this space)

21. In the electrolysis of aqueous $CuSO_4$ the product at the cathode is

21.
A. Cu^{++}
B. Cu
C. O_2
D. H_2

Questions 22 through 25 refer to the following information.

An atom has 2 K electrons, 8 L electrons, 18 M electrons and 3 N electrons. Its atomic weight is 70 a.m.u.

22. In the periodic table this element is in group

22.
A. IIIA
B. IVB
C. VA
D. VIIB

23. The total number of p electrons is

23.
A. 19
B. 13
C. 12
D. 6

24. The number of chlorine atoms which would combine with this atom is

24.
A. 1
B. 2
C. 3
D. 4

25. The number of neutrons in the nucleus of this atom is

25.
A. 31
B. 39
C. 70
D. 101

FOR ROUGH WORK
(No marks given for work in this space)

Questions 26 and 27 refer to the following equation.

$$KClO_3 + 6KBr + 3H_2SO_4 \longrightarrow KCl + 3Br_2 + 3K_2SO_4 + 3H_2O$$

26. One gram equivalent of $KClO_3$ would weigh

26. A. 20.4 gm.
B. 80.0 gm.
C. 119.0 gm.
D. 122.5 gm.

27. The number of grams of KBr that one gram equivalent of $KClO_3$ would completely react with is

27. A. 20.4 gm.
B. 80.0 gm.
C. 119 gm.
D. 122.5 gm.

Listed below are some conclusions made as a result of experiments performed to study the structure of the atom.

(1) The charge of an electron is -1.60×10^{-19} coulombs.
(2) The charge-to-mass ratio of an electron is -1.76×10^{8} coulombs per gram.
(3) The energy possessed by an electron is quantized.
(4) The atom has a nucleus in which its positive charge and mass are concentrated.

Identify which of the above conclusions was obtained by each of the experiments described in questions 28 through 30.

28. J. J. Thompson quantitatively measured the deflection of beams in discharge tubes by electric and magnetic fields.

28. A. 1
B. 2
C. 3
D. 4

29. R. A. Millikan performed a classic experiment now referred to as the "Oil-Drop Experiment".

29. A. 1
B. 2
C. 3
D. 4

30. Lord Rutherford studied the scattering of alpha particles by metal foil.

30. A. 1
B. 2
C. 3
D. 4

FOR ROUGH WORK

(No marks given for work in this space)

Questions 31 through 33 refer to the following information. The possible binding forces in solids are:

(1) van der Waals and/or dipole-dipole
(2) electrostatic attraction
(3) shared electrons
(4) electrical attraction between positive ions and negative electrons

31. The binding force in solid iron is

31. A. 1 only
B. 2 only
C. 2 and 3
D. 4 only

32. The binding force in diamond is

32. A. 1 only
B. 2 and 4
C. 3 only
D. 4 only

33. The binding force in graphite is

33. A. 1 only
B. 1 and 3
C. 3 and 4
D. 4 only

Questions 34 and 35 refer to the following half-reactions under standard conditions:

$Cu \longrightarrow Cu^{+2} + 2e^-$ −0.34 V (1)
$2Br^- \longrightarrow Br^{+2} + 2e^-$ −1.09 V (2)
$4H_2O + Mn^{+2} \longrightarrow MnO_4^- + 8H^+ + 5e^-$ −1.51 V (3)

34. The best reducing agent is

34. A. Cu
B. Mn^{+2}
C. MnO_4^-
D. Cu^{+2}

35. The voltage of the galvanic cell using the half-reactions (1) and (3) is

35. A. −1.85 V
B. −1.17 V
C. +1.17 V
D. +1.85 V

FOR ROUGH WORK

(No marks given for work in this space)

Questions 36 through 38 refer to the following data obtained from experiment 12, Heat of Reaction - Neutralization:

A clean dry erlenmeyer flask was weighed. 100 ml of 0.50 M HCl was placed in the flask. 100 ml of 0.50 M KOH was measured. The temperature of both the acid and base solution was taken. The two solutions were mixed and the final temperature taken.

Observations:	The original temperature of HCl was	20.1° C
	The original temperature of KOH was	20.1° C
	The final temperature of mixture was	22.5° C
	The weight of the flask was	125 gm.

36. If the specific heat of the solutions is 1 calorie per gram per centigrade degree and the density is 1 gram per milliliter then the total heat absorbed by the liquid is

36.
A. 240 calories
B. 480 calories
C. 540 calories
D. 600 calories

37. The net ionic equation for the chemical reaction is

37.
A. $K^+ + OH^- + H^+ + Cl^- \rightarrow K^+ + Cl^- + HOH$
B. $H^+ + OH^- \rightarrow HOH$
C. $KOH + H^+ \rightarrow HOH + K^+$
D. $HCl + OH^- \rightarrow HOH + Cl^-$

38. The total heat liberated by the reaction was 540 calories. The heat of reaction per mole of H^+ is

38.
A. 4.80×10^2 calories
B. 6.00×10^3 calories
C. 1.08×10^4 calories
D. 5.40×10^5 calories

39. One method of determining the concentration of an acid is by titration. This method is known as . . . analysis.

39.
A. volumetric
B. gravimetric
C. calorimetric
D. colorimetric

40. In a neutralization reaction the indicator used was phenolphthalein. As the base was added to the acid the end point was indicated when the solution turned

40.
A. colorless
B. blue
C. red
D. orange

FOR ROUGH WORK

(No marks given for work in this space)

Values

3 **41.** Solid potassium fluoride will not conduct an electric current but molten potassium fluoride will. Explain briefly.

2 **42.** Distinguish between ionization potential and electron affinity.

2 **43.** Boron trifluoride, BF_3, is a non-polar molecule but each boron-fluorine bond is polar. Explain briefly.

FOR ROUGH WORK

(No marks given for work in this space)

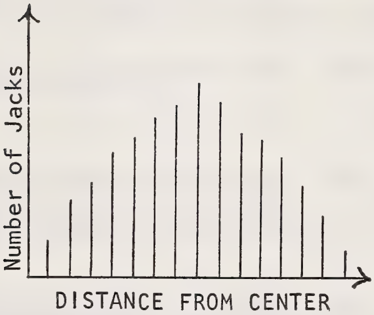
Values

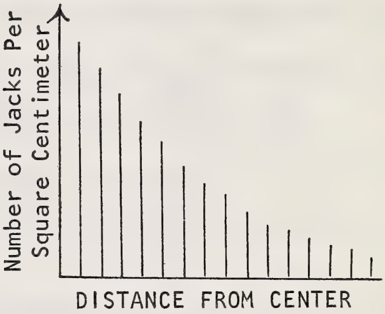
8 **44.** Write the electron-dot formula of each of the following:

(a) N_2 (b) $S^=$

(c) CaO (d) H_2S

4 **45.**





The above graphs represent the composite results of the experiment "Probability Patterns" done by one class.

(a) Both graphs represent the same distribution in space. Explain.

(b) When graph B is related to the electrons in the 1s hydrogen orbital what information is given concerning this electron?

Values

6 **46.** (a) State the physical conditions under which ordinary gases show a large deviation from ideal behavior.

....

....

....

....

(b) What two assumptions of the kinetic theory of gases are no longer applicable when gases exhibit nonideal behavior?

(1) ....

....

(2) ....

....

(c) If a gas is highly compressed at very high temperature it will not liquefy. Explain.

....

....

....

....

FOR ROUGH WORK

(No marks given for work in this space)

Values

8 **47.** Balance the following equations by the method indicated. All steps of each method must be shown.

(a) Oxidation Number Method

$HBr + H_2SO_4 \longrightarrow SO_2 + Br_2 + H_2O$

(b) Half Reaction Method

$CuS + NO_3^- \longrightarrow NO + S + Cu^{++}$ (acidic)

FOR ROUGH WORK

(No marks given for work in this space)

Values

12 **48.** Name each of the following compounds and write the structural formulas.

(a) $CH_3OCH_2CH_3$ Name ....

Structural Formula:

(b) $CH_3COOC_2H_5$ Name ....

Structural Formula:

(c) $NH_2C_3H_6NH_2$ Name ....

Structural Formula:

(d) $C_2H_5COC_3H_7$ Name ....

Structural Formula:

FOR ROUGH WORK

(No marks given for work in this space)

Values

10 **49.** Define or explain each of the following terms. Use complete sentences.

(a) Lattice Energy

(b) Oxidation Potential

(c) Isomers

(d) Dielectric Constant

(e) Bond Energy

Values

2 **50.** Calculate the weight in grams of 0.130 moles of Na_2O_2.

3 **51.** Calculate the number of gram-atoms of oxygen in 63.8 grams of $CaSO_4$.

FOR ROUGH WORK
(No marks given for work in this space)

Values

52. Analysis of a compound showed it contained 26.58% K, 35.35% Cr and 38.07% O by weight.

4 (a) Determine the simple or empirical formula of the compound.

2 (b) The weight of Cr present was 17.5 gm. What was the total weight in grams of the sample analyzed?

FOR ROUGH WORK

(No marks given for work in this space)

Values

3 **53.** Given the reaction $Sb_2S_3 + 6HCl \longrightarrow 2SbCl_3 + 3H_2S$

Calculate the volume of gaseous HCl at S.T.P. required to produce 1.806×10^{23} molecules of H_2S.

5 **54.** Determine the temperature in degrees centigrade of 6.60 gm. of CO_2 in a 3.60 liter container under a pressure of 988 millimeters Hg.

FOR ROUGH WORK

(No marks given for work in this space)

Values

5 **55.** A current of 10.0 amp. is passed through molten $MgCl_2$ for 15.0 min. What weight of magnesium is produced at the cathode?

$$MgCl_2 \longrightarrow Mg + Cl_2$$

5 **56.** If 15 ml. of 0.50 M $CaCl_2$ is added to 50 ml. of 0.10 M $CaCl_2$, what will be the resulting concentration of $CaCl_2$, assuming volumes are additive?

FOR ROUGH WORK

(No marks given for work in this space)

Values

2 **57.** Given the equation $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O + 212.9$ Kcal. Determine the heat produced when 7.72 l of CH_4 at S.T.P. are completely burned.

2 **58.** Given the equation $P_4 + 6H_2 \longrightarrow 4PH_3$. Calculate the weight in grams of PH_3 produced, when 10 gm. of P_4 are allowed to react with 1.2 gm. of H_2.

FOR ROUGH WORK

(No marks given for work in this space)

Values

6 **59.** Complete the following by writing the appropriate answer in the space provided.

A solution was suspected to contain a mixture of Ag^+ ion, Fe^{+++} ion, Cu^{++} ion only.

(a) Some 6M HCl was added to the portion of the solution. A white precipitate formed.

Conclusion ....

Formula of the precipitate ....

(b) To the remaining solution a few drops of 6M NH_4OH was added and a rusty colored gelatinous precipitate formed.

Conclusion ....

Formula of the precipitate ....

(c) An excess of NH_4OH was then added and a deep blue solution formed.

Conclusion ....

Formula of the ion giving the dark blue color ....

FOR ROUGH WORK

(No marks given for work in this space)

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